

Off-axis-NOTE-GAS-0015

Adhesion strength of spacers in Glass RPC chambers

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Abstract

Measurements of the adhesion strength of noryl spacers and glass plates were conducted. The resulting bond withstands loads up to 1.8 Kg/cm of a spacer. Glass RPC chambers, from the point of view of the structural integrity, can withstand an overpressure up 0.09-0.18 atm, depending on the spacers pitch.

1 Introduction

Glass Resistive Plate Chambers consists of two thin float glass plates separated with plastic spacers. Edge pieces serve as spacers and as the gas seal at the same time. Detection efficiency of the RPC depends primarily on the electric field strength in the chamber volume and this, in turns, depends on the applied voltage and the distance between the plates: $E = \frac{V}{d}$. The voltage applied is the same across the entire area of the chamber, thus uniformity of the effective electric field is determined by the uniformity of the plates spacing. This is the main function of the spacers. In a BELLE-like chamber design the spacers form a maze-like channel for the gas flow to improve uniformity of the gas composition over the entire volume of the chamber.

The distance between the glass plates of a chamber constructed with perfectly uniform spacers may vary with the variation of the atmospheric and/or internal gas pressure. The resulting bow of the chamber depends on the spacer spacing and on the glass thickness. The chamber design must ensure that this distance variation is small compared to the length of the HV plateau curve.

From the practical point of view it is desirable that chambers are robust and that they can tolerate large variation of the atmospheric pressure. Large atmospheric pressure drop caused by a passing low pressure front may lead to de-lamination of glass plates and to a catastrophic failure of the whole experiment. Such a risk is clearly unacceptable. This note investigates the robustness of the BELLE design of glass chambers glued with 2 mm wide spacers.

2 Test samples

Two 2.5×2.5 cm glass pieces were glued using different types of glues:

- 10 minutes epoxy 3M 810
- structural epoxy 3M 2216 grey
- structural epoxy 3M 2216 translucent
- 3M transfer tape

Four samples were produced for each condition, except for the transfer tape case, where only three samples were prepared. Samples using 3M epoxy were prepared using BELLE-design noryl spacers: 2 × 2 mm square cross section with a groove for epoxy, see Fig. 1.

Transfer tape requires a flat surface for good adhesion, therefore a square brass rod was used instead of a noryl spacer. To enable a controlled and uniform delaminating force to be applied to the glue joint aluminum T-blocks were glued to the

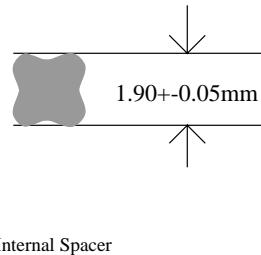


Figure 1: Cross section of a spacer

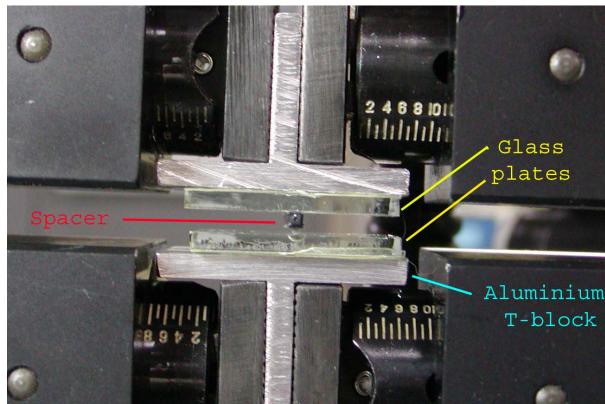


Figure 2: Test assembly

glass plates, as shown in Fig.2 using double-sticky tape. The expectation was the adhesion strength of the tape over the entire area of the glass plate will exceed that of the glue joint of the spacer.

3 Testing procedure and results

Samples were tested using an Universal Testing Machine Instron 4411 shown in Fig. 3. Two aluminum T blocks were mounted in the jaws of the Instron and pulled away with constant speed. A resulting force was recorded as a function of a vertical displacement of the jaws, as shown in Fig. 4.

As the glass plates are pulled apart the resisting adhesive force is increasing too until it reaches its maximal value. This value is defined to represent a glue joint strength. The results of the measurements for all the samples are shown in Fig. 5

There are several observations resulting from these tests:

- the force required to delaminate the 2.5 cm long spacer from the glass plate is in excess of 10 lb. One data point showing delamination at 7 lb corresponds to the case where the aluminum T-block started to delaminate from the glass, rather than then spacer
- the actual adhesion strength varies from sample to sample by up to a factor two for the epoxied spacers



Figure 3: Universal Testing Machine Instron 4411

- adhesion strength of spacers glued using a transfer tape shows much greater consistency, albeit the tested sample is rather small.

4 Overpressure limit of the glass chambers due to a spacers adhesion.

From the above measurements we conclude that 10 lb, or 4.5 kG, is a conservative limit on the force required to delaminate the 2.5 cm long spacer. The limiting load is, therefore 1.8 kG/cm. The spacers pitch, s , in the chamber is typically of the order of 10-20 cm. On overpressure p inside the chamber will produce a delaminating force per unit length

$$F = ps$$

thus the limiting pressure the chamber can withstand, from the point of view of the structural integrity of the glue joints is:

$$p = \frac{F}{s} = \frac{1.8 \text{ kG/cm}}{10 - 20 \text{ cm}} = 0.09 - 0.18 \text{ kG/cm}^2 = 0.09 - 0.18 \text{ atm}$$

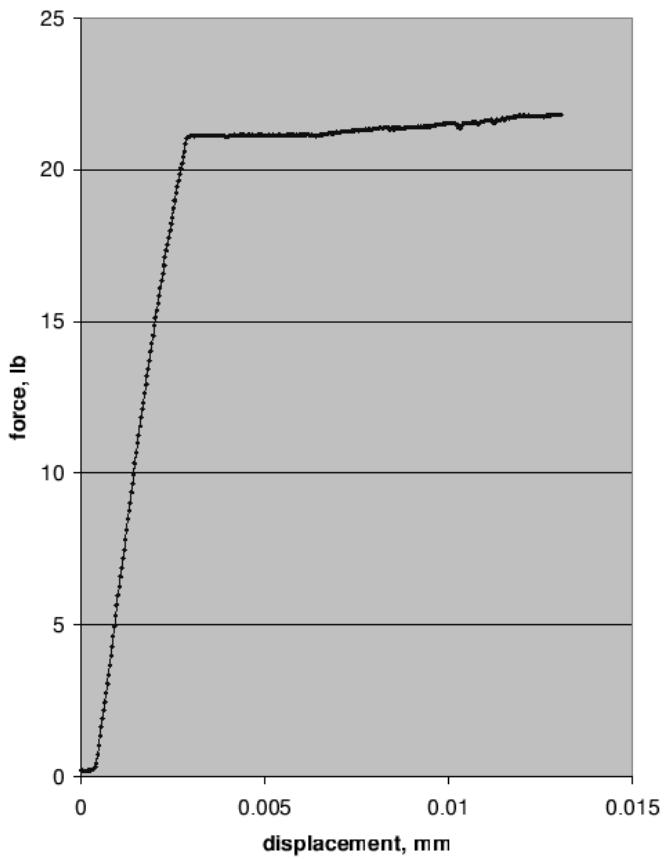


Figure 4: Pulling force as a function of a displacement

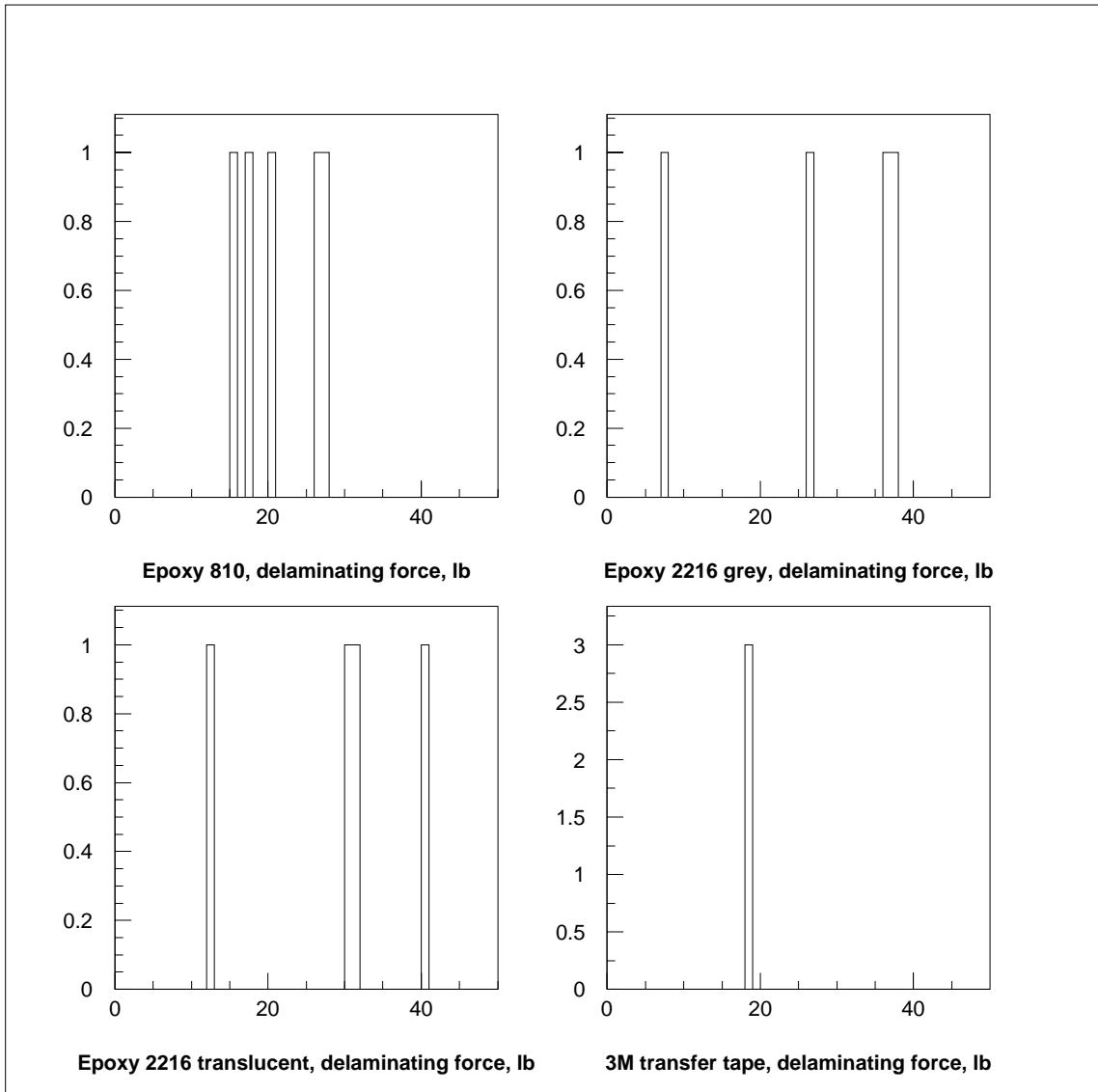


Figure 5: Distribution of the delaminating force for different samples